FAR-INFRARED RAY SNOW-MELTING SYSTEM

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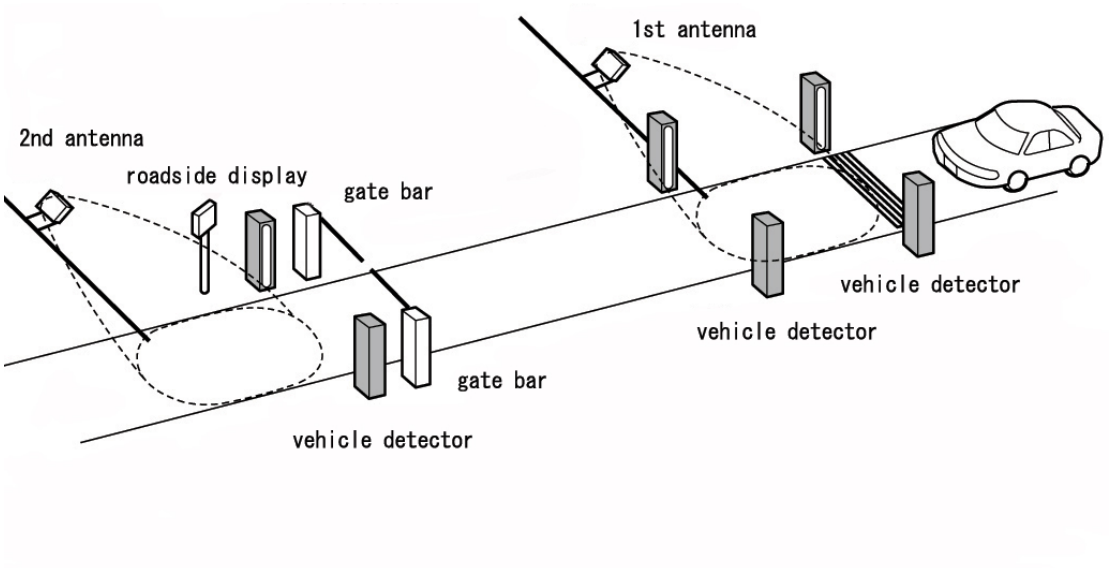
ABSTRACT

This is the system that brings about the effect of snow-and-ice melting and fog dispersion on a road and its surrounding area by effectively generating and radiating far-infrared rays whose wavelength range is easily absorbed by snow, ice and fog. After carrying out tests, we verified that the system has turned out effective in preventing the snow and ice from sticking on the sensors on ETC lanes and other equipment.

ETC SYSTEM IN JAPAN

As shown in Fig. 1, this system consists of antennas for wireless communications, a roadside display, a gate bar and vehicle detectors. A car passes through an ETC gate nonstop in Japan.



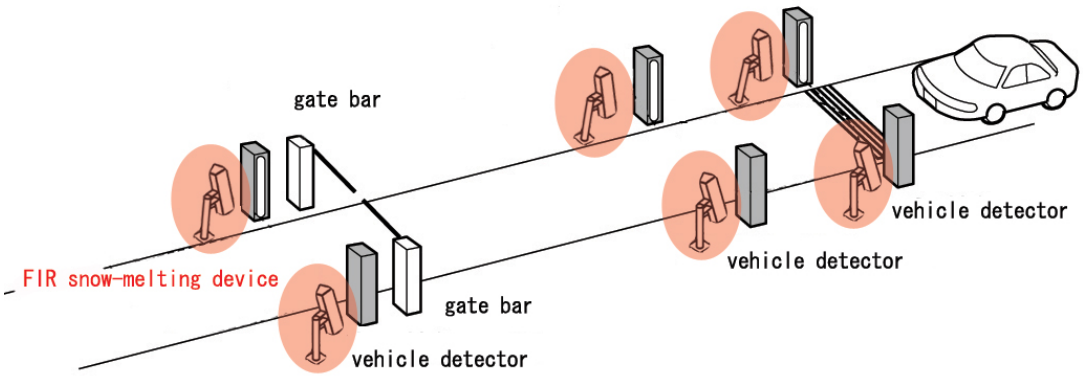
(Fig. 1)

What is the problem?

In Japan, there are cases in which sensor signals are cut off due to snowfall on the vehicle detector base and a gate entrance or due to snow accretion on the vehicle detector itself. This situation makes a vehicle unable to run and eventually leads to a road blockage.

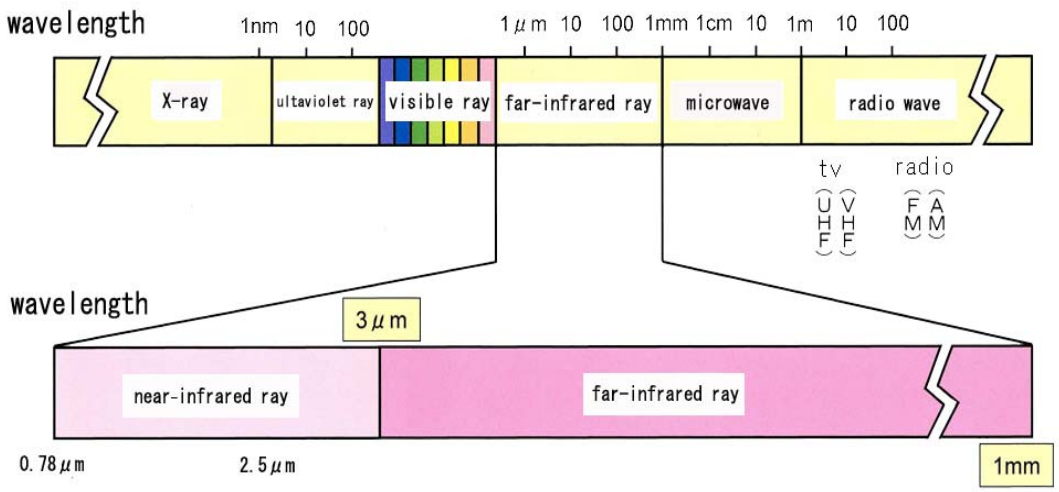
How to solve the problem?

By installing FIR (far-infrared ray) snow-melting system to prevent snow from accumulating, freezing and adhering on the devices and in their vicinity. (Fig. 2)



(Fig. 2)

What is FIR (far-infrared ray)?

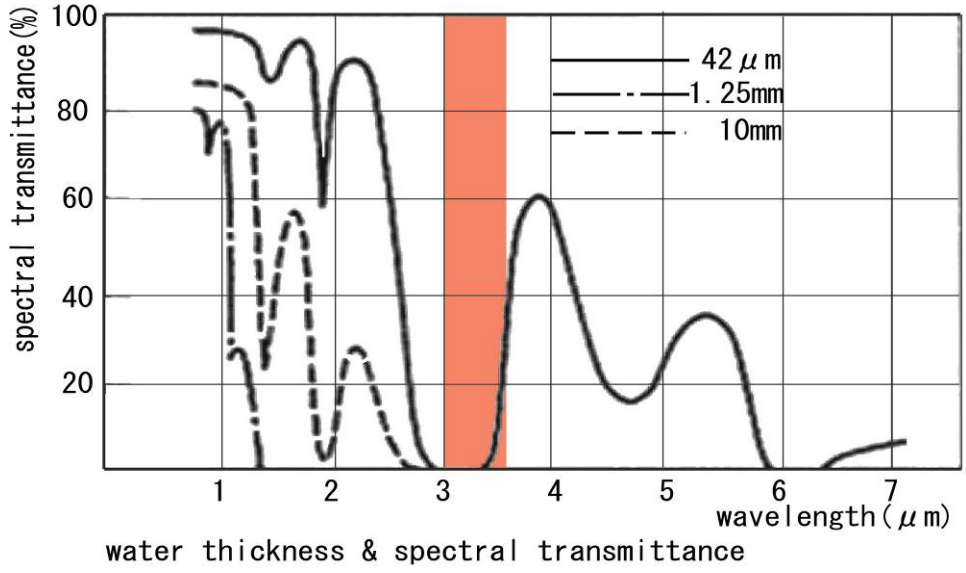


(Fig. 3)

FIR is one of electromagnetic waves like x-ray, ultraviolet ray, visible light ray, microwave and radio wave. The ray in the wavelength range of 3μm-1mm is defined as a far-infrared ray (refer to Fig. 3). In particular, the one in the range of 3-25μm has a distinguished feature of being absorbed when it shoots the material surface and converted into energy by vibrating the molecules and crystal lattice of the material.

FIR absorption characteristics

Fig. 4 shows at which wavelength 3 kinds of water layers in 42μm、1.25mm and 10mm are absorbed. It is evident that all the water layers are most effectively absorbed in the range of 3μm-3.5μm.

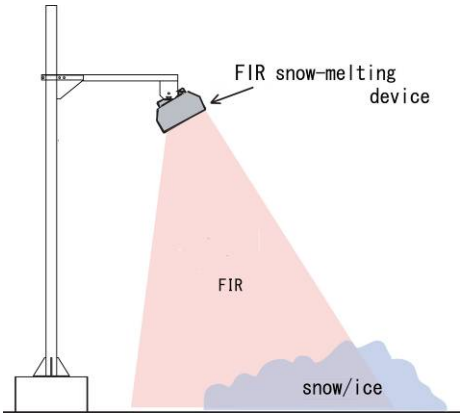


(Fig. 4)

Characteristics of FIR

(Irradiation)

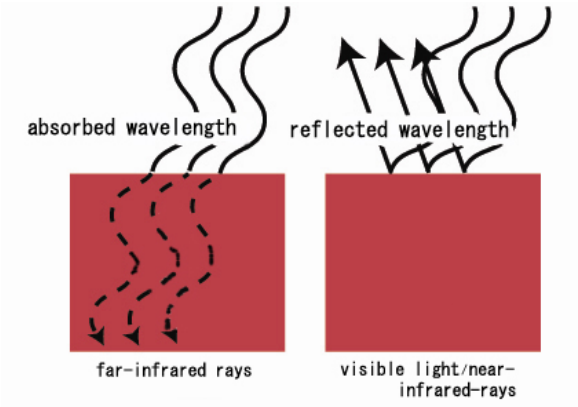
The infrared rays emitted from a heat source go straight in space and shoot the material surface with the speed (about 300,000km/second). The infrared rays are electromagnetic waves that travel with no influence of air, wind, temperature, etc.



(Fig.5)

(Infiltration)

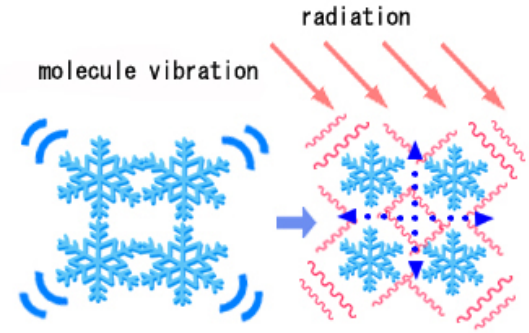
Visible light and near-infrared rays are reflected on the material surface and not easily absorbed by snow and ice. Far-infrared rays, however, infiltrate the snow, ice, water and fog deeply since they are in the wavelength range with high absorptivity.



(Fig.6)

(Resonance)

Absorbed far-infrared rays accelerate water molecule vibration. By doing molecule vibration lively, a temperature rise occurs, resulting in the decomposition of the material. (Refer to Fig. 7).

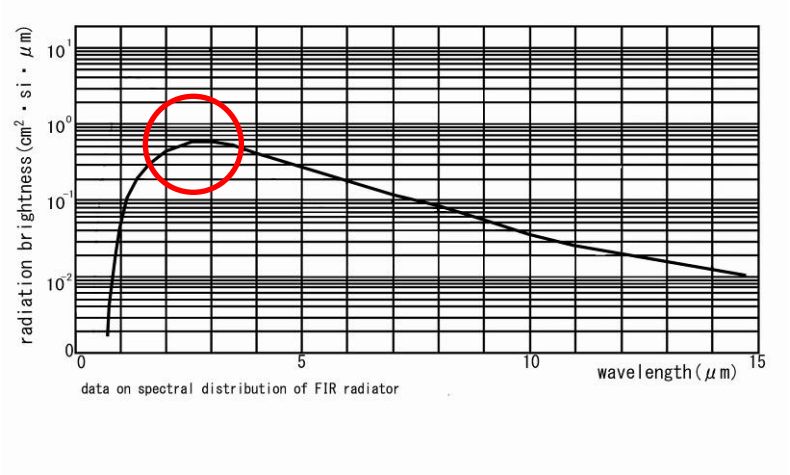


(Fig. 7)

FIR radiator

The FIR radiator coated with special ceramic has been designed for the purpose of irradiating a wavelength similar to that of water, snow, ice and fog. This radiator is able to emit far-infrared rays in the wavelength range of 3μ-3.5μm where its spectral absorptivity reaches the maximum level (Refer to Fig. 4) and is expected to bring about a wonderful effect on water, snow, ice and fog.

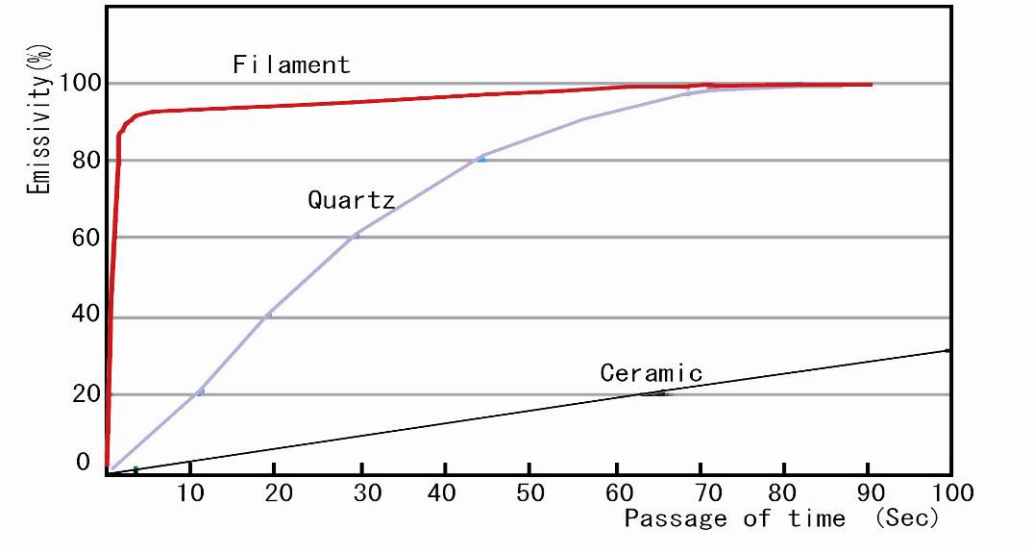
FIR irradiation peak wavelength



(Fig.8)

Characteristics of FIR radiator

Since the FIR radiator has as its heat source a filament that has a lower thermal capacity than ceramic or quartz, it is possible to start or stop its operation immediately after it is switched on or off. This enables you to cope with complicated programs.



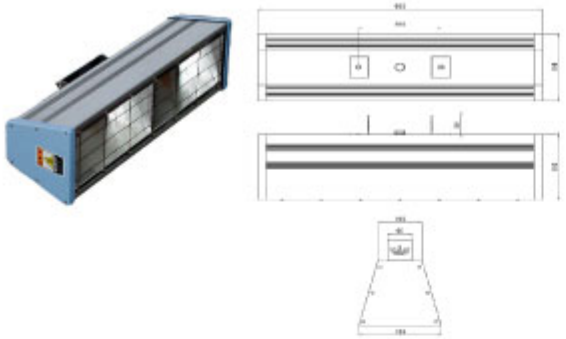
(Fig.9)

Development of FIR snow-melting device

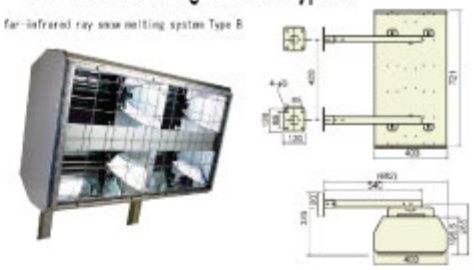
This device has been developed to melt snow and ice that covers the vehicle detectors, ETC lane, etc.

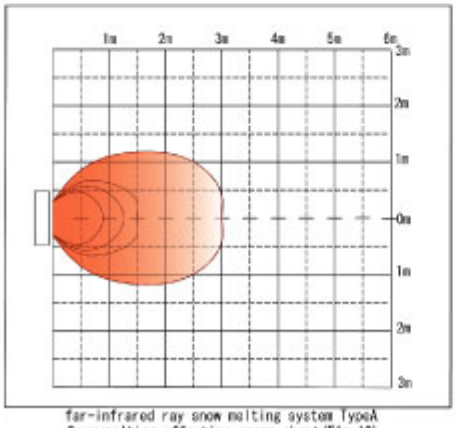
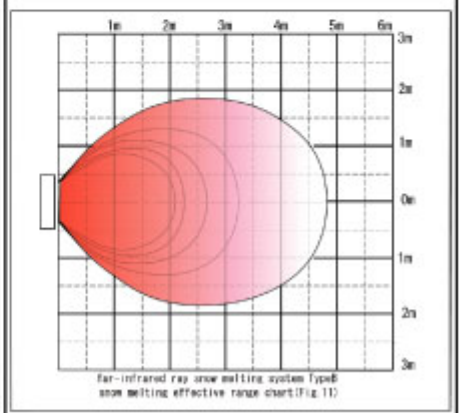
Difference in specifications between Type A and Type B

FIR snow-melting device Type A



FIR snow-melting device Type B

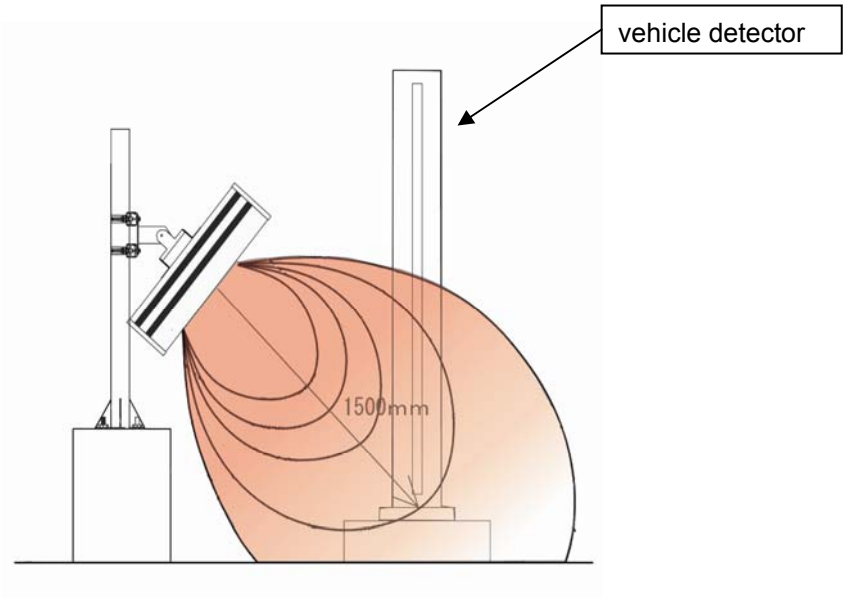


	FIR snow melting system typeA	FIR snow melting system typeB
Irradiation distance	Refer to Figure 10.	Refer to Figure 11.
Irradiation coverage	Refer to Figure 10.	Refer to Figure 11.
Voltage	100V 50/60Hz	200V 50/60Hz
Power consumption	1000W	4000W
Heat source	Harogen Heater(Special, ceramic coating)	Harogen Heater(Special, ceramic coating)
Main body material	Aluminum	Stainless steel(SUS304)
Reflector material	Aluminum	Aluminum
Size	688*192*199	721*682*325
Weight	5.0kg	14Kg
	 far-infrared ray snow melting system TypeA Snow melting effective range chart(Fig. 10)	 far-infrared ray snow melting system TypeB snow melting effective range chart(Fig.11)

How to use the system

FIR snow-melting system Type A

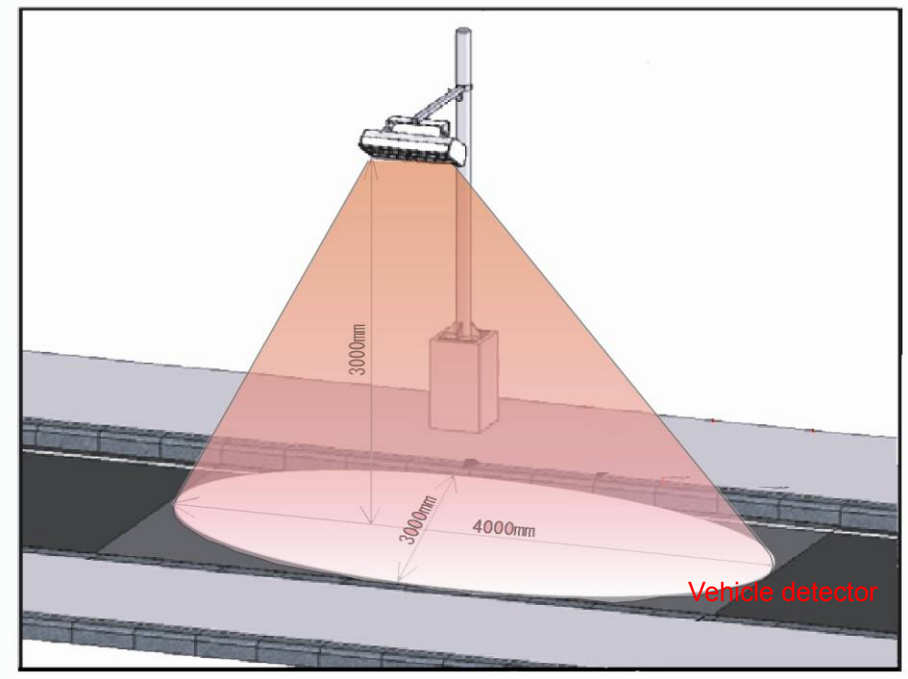
Type A is designed to melt snow and ice that covers the vehicle detector and its base, as shown in Fig. 12.



（Fig.12）

FIR snow-melting system Type B

Type B is designed to melt snow and ice that covers the ETC lane. The device installed at the place 3000mm above the ground can radiate far-infrared rays in a wide range, as shown in Fig. 13.



（Fig.13）

FIR snow-melting device tests

Indoor test using Type B

We created a snowfall of 30mm on the road with an artificial snow making machine and irradiated far-infrared rays with Type B to see how the snow melts.

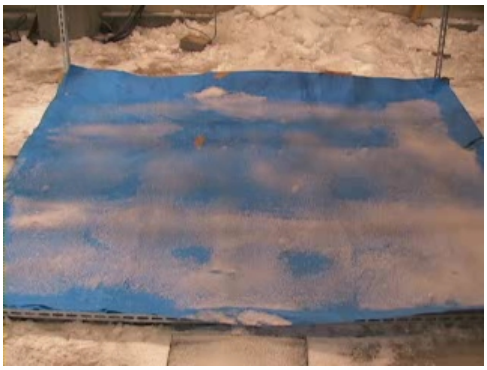
Data on experimental environments
Device for test　FIR snow-melting device Type B (AC200V 400W)
Position of installed device　3000mm above the ground
Test room temperature　－10 – 14° c
Road surface temperature　－20° c
Humidity　97%
Snow density　0.3 - 0.5

（Installation of Type B）

（start）

（30 minutes later）

（60 minutes later）



（90 minutes later）

Test results

The test was carried out under such tough conditions as low ground temperature, high humidity and the snow turning nearly into ice, which are a far cry from natural environments. It took 90 minutes for the snow to melt to the extent that we could see the road surface. If we applied it to the natural snow, we presume that it would require much less time to melt it.

ETC field test and verification of its test results

Test results

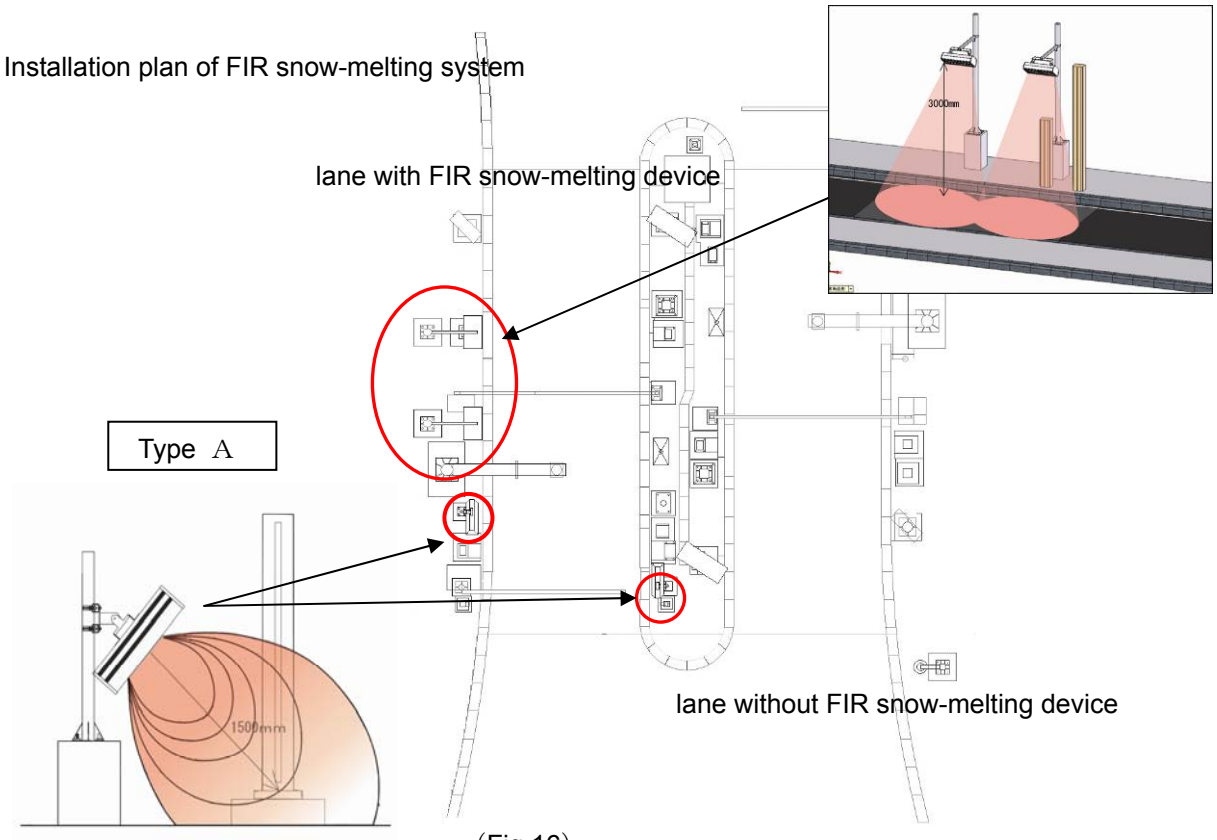
We created the circumstances as close to those in a real winter season as possible by producing snow with an artificial snow making machine (Fig. 15) – the road and the vehicle detectors are covered with artificial snow. We compared the snow melting power in the lane equipped with the FIR snow-melting device and without it (Fig. 16). The test was conducted at the outside temperature of -1℃ with snowfall of over 50mm/h.

View of test site

(Fig.14)

Snowfall by artificial snow-making machine

(Fig.15)



(Fig.16)

Snow melting test with Type A and its verification

We compared the snow melting conditions in ETC lanes with Type A and without it. Fig. 17 shows that the vehicle detector base is covered with snow in the lane without Type A, while there is no snow in the lane equipped with the device, as shown at Fig. 18.

before installation

（Fig.17）

after installation

（Fig.18）

Snow melting test with Type B and its verification

We checked the snow melting conditions in ETC lanes with Type B and without it. As shown in Fig. 19, the lane without Type B is covered with artificial snow that is produced by snow-making machine, but the snow is gone in the lane with the device right after the far-infrared rays are irradiated.

（Fig.19）

Conclusion

Our tests have proven that both Type A and B are effective in removing the snow that covers the vehicle detector base as well as the ETC lane and do not cause any troubles to the vehicle detector.

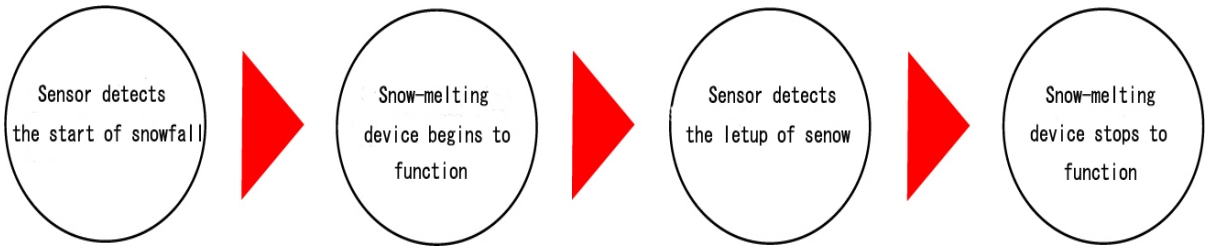
Future improvements

The following improvements need to be made to reduce electricity consumption and operate the system effectively.

1. To miniaturize (or enlarge) the device itself in accordance with the irradiation area.

2. To control the operation with a snow sensor

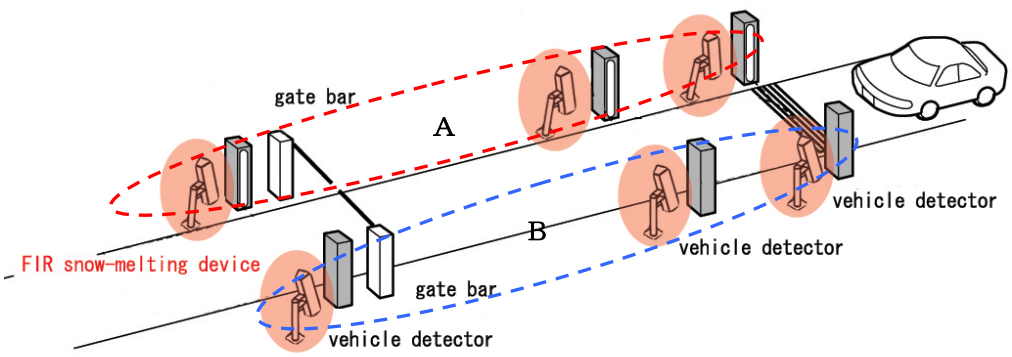
To control the flow of operation with a snow sensor



3. Alternative operation of multiple devices

We will be able to reduce the total electricity consumption of FIR snow-melting device by operating several devices alternatively and achieve the most effective snow-melting effect with a minimum of electricity.

The electricity consumption will be reduced to half by alternatively supplying electricity with 3 units that are installed in the “A” area and “B” area respectively.



Applications of FIR snow-melting system to facilities in service areas and parking areas.

This is the system that enables you to stay away from the troubles of snowfall and freeze and to make safe and handy use of facilities in service areas and parking areas around the clock.

Hallway

Before installment

（Fig.20）

This is the case where the hallway is covered with blown-in snow and gets slippery before the FIR snow-melting device is installed. (Fig. 20)

After installation

（Fig.21）

Snow at the irradiated area (Fig. 21) gets melted and dry by installing the FIR snow-melting device, and we have ascertained this system to be effective as measures to cope with a walking difficulty on a snowy road and such an accident as falling down on an icy road.

Other applications

We are studying the possibility of introducing this system into the wheelchair ramp of handicapped persons, the shop entrances, the passage for workmen (steel stairways), etc.